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ABSTRACT

This guide describes the use of microforms (including microfilm and microfiche) in a training environment, provides basic background on microforms as a distinct communications medium, and illustrates the steps required to operationalize the use of microforms in a training sequence. The guide is based on information developed through studies of educational microform uses, together with data accumulated from specialists in the areas of filmed materials' development and equipment design. The guide describes: 1) general information on microforms, including definitions and explanations of terms, materials, and concepts; applications and acceptance; new techniques and processes; costs, and information sources; 2) the use of microforms in a direct instructional mode and the relationship of microform capabilities to training applications; 3) considerations to be made in any specific instructional application, including plans for instructional materials, delivery, and use. (Author/JK)

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AFHRL-TR-71-44

A GUIDE TO INSTRUCTIONAL USES OF MICROFORM

By

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Lowry Air Force Base, Colorado

May 1971

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AIR FORCE SYSTEMS COMMAND
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FOREWORD

This Guide to the instructional use of microform has been prepared to provide the background necessary for further refinement of the concept. Microform, used as an instructional tool, is a very new application in educational technology; this Guide, while written at the introductory level, provides the essential information for continued development of instructional applications.

The information presented is based, in part, on the experience gained through an experimental study in which the considerations involved in preparing and implementing a course of instruction using microform were identified empirically (AFHRL-TR-71-44).

The preparation of the Guide was performed under Contract No. F41609-70-C-0040 by the Denver Research Institute of the University of Denver, under the direction of the Technical Monitor, Dr. Edgar A. Smith of the Air Force Human Resources Laboratory, Lowry Air Force Base, Denver, Colorado. The project was supervised by Mr. James P. Kottenstette. Research Associates contributing to the program were Mr. Robert R. Grausnick, Mrs. Alta Bradley Morrison and Dr. Anita S. West. This study represents a portion of the research program of Project 1121, Technical Training Development; Task 112101, Advanced Technology for Air Force Technical Training. Dr. Marty R. Rockway was the Project Scientist and Mr. Joseph Y. Yasutake was the Task Scientist.

Other reports prepared under this contract include:

AFHRL-TR-71-42, "A Performance Evaluation: Microfiche versus Hardcopy"

AFHRL-TR-71-43, "Microform Use in a Technical Training Environment -- An Experiment"

This Guide has been reviewed and is approved.

GEORGE K. PATTERSON, Colonel, USAF
Commander

ABSTRACT

The objective of this Guide is to present information on the use of microforms in a training environment; to provide basic background on microforms as a distinct communications medium; and to illustrate the steps required in operationalizing the use of microforms in a training sequence.

Information developed through studies of educational microform uses, together with data accumulated from specialists in the areas of filmed materials' development and equipment design, have provided the basis for creation of this Guide to microform uses in a training environment.

A review of the material to be presented resulted in the preparation of three chapters for the instruction of individuals requiring an understanding of the subject: (1) general information on microforms to include definitions and explanations of terms, materials, and concepts; applications and acceptance; new techniques and processes; costs; and information sources; (2) the use of microforms in a direct instructional mode and the relationships of microform capabilities to training applications; and (3) the considerations to be taken into account in any specific instructional application, which include a plan for instructional materials, a plan for delivery, and a plan for use; as well as an outline for design and implementation of such an operation.

SUMMARY

Denver Research Institute, University of Denver, A Guide to Instructional Uses of Microform. AFHRL-TR-71-44, Lowry AFB, Colorado: Technical Training Division, Air Force Human Resources Laboratory, May 1971.

Objective

The objective of this Guide is to present information on the use of microforms in a training environment; to provide basic background on microforms as a distinct communications medium; and to illustrate the steps required in operationalizing the use of microforms in a training sequence.

Approach

Information developed through studies of educational microform uses, together with data accumulated from specialists in the areas of filmed materials' development and equipment design, have provided the basis for creation of this Guide to microform uses in a training environment.

Findings

A review of the material to be presented resulted in the preparation of three chapters for the instruction of individuals requiring an understanding of the subject: (1) general information on microforms to include definitions and explanations of terms, materials, and concepts; applications and acceptance; new techniques and processes; costs; and information sources; (2) the use of microforms in a direct instructional mode and the relationships of microform capabilities to training applications; and (3) the considerations to be taken into account in any specific instructional application, which include a plan for instructional materials, a plan for delivery, and a plan for use; as well as an outline for design and implementation of such an operation.

This summary was prepared by Dr. Edgar A. Smith, Technical Training Division, Air Force Human Resources Laboratory.

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CHAPTER I

MICROFORMS: GENERAL INFORMATION

A. Background

This Guide presents information primarily on the development and current use of microfiche materials in a training environment. The level of sophistication of materials and equipment, as presented here, is that considered readily useful for the indoctrination of and utilization by trainees and instructors in an Air Force Technical Training School environment. Extensive treatment of complicated use patterns and gear are avoided, as well as sophisticated or exotic systems to achieve communication, since the training condition focused upon is that of classroom instruction.

Many individuals, industrial concerns, research teams, and educators are currently involved in developing materials, equipment, and systems to utilize microforms in the educational environment. For some time, microforms have been accepted and used in industry for administrative purposes, such as compressing files and records into a small space, lowering costs of mailing information from one place to another, developing ready access to statistical data through automatic retrieval of filmed information, and utilizing the film medium to reduce costs of duplicating materials. In libraries, too, microforms are accumulating rapidly; some of the applications include the acquisition of out-of-print materials, the reduction of costs in acquisition and storage, and the replacement of bound serials with less costly film copies. Actual use of these materials within educational institutions has been very limited, and only in the last several years has the possibility of active use of microforms in the instructional process

been seriously considered. Before discussing the instructional uses of microform, the following review of the state-of-the-art in micropublishing is presented.

B. Definitions; Explanations

1. Microforms

Microforms are visual materials which contain information that is recorded in a size too small to be identified by the naked eye; some magnification of the image(s) on a microform must be achieved before the information held in "microimagery" can be utilized. A large, printed notice might be photographically reduced to a smaller size and still be easily read without optical aid; this would not be a microform. However, if the material were further reduced in size until one could no longer decipher its message, and a magnifying lens were required in order that it might be read, then that greatly reduced image would be a microform. Microforms are encountered in numerous modes, sizes, shapes, and reductions, some of which are described below. Although some microforms are planned for use by groups of individuals, those of concern in this Guide are developed for use by people viewing them singly.

a. Opaques are microforms which are developed on materials which will not transmit light, such as sheets of paper or card stock. These forms require the reflection of the image onto another surface, along with magnification, in order that they may be read, or they may be read directly through a magnifying lens. These images can be printed photographically or by means of a highly developed lithographic process but the reductions are seldom greater than 20 times that of the original, and normally are only 5 to 10 times the original.

These microimages are printed on letter-sized sheets of paper, as microsheets; on smaller sheets or cards (microcards), some being only 3 by 5 inches overall; and on narrow tape which can be cut and pasted to a sheet or card as desired. Especially designed equipment is required for viewing these materials.

b. Transparencies are "see-through" materials used for storing information, primarily consisting of films of various types. These microforms are always obtained through a photographic process. The original film used for taking a picture for a microform is silver halide microfilm; it consists of a base of fire-resistant acetate or polyester, a gelatin layer in which grains of silver halides repose, and an element to reduce any light-scattering effect in the film itself. Other film types used to provide transparent dissemination copies of the original microfilm are diazo and vesicular (Kalvar) films. Diazo films are developed through a chemical reaction involving dyes; vesicular films involve the creation of minute bubbles that cast shadows which create the image areas. Transparencies are unitized in two primary modes; as a long strip of images wound into a roll, or as a flat piece of film on which a number of images are imposed utilizing a coordinate system. Roll film is produced in varying widths, 35-millimeter being the width which was widely employed in the past and is still used extensively for filming of large-sized documents such as newspapers and engineering drawings. For smaller-sized materials, such as report literature and textual information, 16-millimeter films are now the most widely used, but 8-millimeter images are being developed for some applications. The flat microforms (called fiche, from the French) are commonly produced by cutting 105-millimeter film into cards which are sized approximately 4 by 6 inches,

although other sizes of film cards have been developed and utilized, i.e., 2 by 2 inches and 3 by 5 inches, as well as 5 by 8 inches, and even larger sizes. The flat films are characterized by a horizontal and vertical coordinate system which is used to arrange the images they contain in an orderly fashion. The number of images on a microfiche depends upon the degree to which the materials have been photographically reduced and on their arrangement; smaller image sizes are constantly being developed as better viewing equipment and better films become available. During the past decade, files of material were placed on microfiche by Government agencies utilizing a 16-millimeter image on a 105-millimeter film developing a 4 by 6-inch card containing 6 rows of 12 images each (the COSATI standard). The "step-and-repeat" camera has been developed specifically to produce the fiche format. Viewing equipment must translate the microform into a readable image; therefore, the magnification required for the viewer utilized for this purpose is determined by the reduction ratio used to create the original microimage. Some viewers have variable or exchangeable lenses and film holders; these make such equipment more universal in application but delay viewing when modifications must be undertaken before use. Where an appreciable use of a specific microform is contemplated, viewers which are designed for specific form seem the most appropriate from the user's point of view.

c. Microform devices are mechanical aids to efficient use of various forms for particular applications. Some of these devices are explained below.

Spools or reels are used to store roll film and to deliver it sequentially or serially to the viewer. Such devices are of a size

to hold a particular film width, and of a diameter sufficient for the length of the roll being wound into a single unit. Reels, approximately 4 inches in diameter, are common and the reel is often boxed for storage.

Cartridges and cassettes are holders for roll film which package the film in such a way that it can be inserted into a viewer easily; simplified threading of the film into the viewer is achieved with these devices. Cassettes completely enclose the film whereas cartridges do not. Different viewers require different types of cartridges and cassettes; since these are not interchangeable, film must be initially inserted into the unit that fits the viewer to be used. Currently, efforts are being made to standardize these devices so that they will be more universal. Holders, or cassettes, are being developed also for film cards, or fiche, which will eliminate many difficulties in proper film insertion and aid in maintaining clean and undamaged materials.

Aperture cards are paper file cards with frames of film mounted into windows. Such cards are highly unitized and can be filed, and interfiled, permitting expansion and correlation of information maintained in microform. Since aperture cards are often of the punchcard variety, they can be easily coded for information retrieval and for sorting into categories This type of microform is useful where each image or small group of images are able to stand alone as an information unit. Like aperture cards, the CIM-Card (continuous image microfilm card) holds a limited number of images, this card being made completely of a special acetate film of the diazo type.

Microfilm jackets are transparent pockets into which strip film, or single images, can be slipped and held in place for viewing in the same manner as a fiche. The jackets are made for films of various widths, as 16-millimeter or 35-millimeter, and in sizes most useful such as 4 by 6 inches. These jackets permit the individual development of a flat fiche employing a strip-up process, and the addition of material, or rearrangement of material, is readily accomplished.

Microfiche notebook files are available which permit the arrangement of microfiche of a limited number in a ring binder. These files store about 30 of the 4 by 6-inch fiche per sheet, in pockets, with eye-legible headings on the fiche readily visible for easy retrieval of individual fiche. This type of device for storage of microfiche is useful in development of a particular subject, or in assembling materials on film for a special study. Each fiche here is a unit of information, and the notefile as a whole comprises a larger unit of information which includes all of the fiche.

Storing microforms involves various pieces of equipment and furniture, such as files, cabinets, and shelves. The method of storing microforms to be adopted in a given situation is arrived at administratively from factors prevailing in the particular environment. Of importance are the number of microforms involved; the total system of microform use; who, when, and where the forms are to be read; whether the system will permit free access or controlled access to the materials and equipment. File drawers are very effective in storing microfiche. These can be as centrally-located cabinets; they might also be cabinets dispersed into the areas of the reading stations. Both file cabinets and shelves are suitable for

boxed reels of roll film, and for boxed cartridges and cassettes. Lazy-Susan-type shelves are found useful for these small-sized materials.

Laminating materials are sometimes used as coatings for transparent films for several purposes; one is to prevent film contact so as to prohibit the copying of these materials, and a second is to protect the materials from dust and scratches. In the case of high reduction microforms, such as those at 100-times reduction, or more, any small imperfection, dust, or scratch, will be highly magnified when the image is viewed on a screen. A lamination will eliminate this difficulty to a considerable degree since the focal depth of the projection optics is so shallow that imperfections on the surface of the laminate are thrown far out of focus and have little effect on the projected image. This is not equally true of lower reduction ratio materials.

Coding, indexing and some bibliographic or retrieval information is necessary for all microforms to be useful. Eye-legible information must be on the film itself, as well as in an index or catalog. Establishment of standards for the appropriate access information and auxiliary tools for and in connection with microforms is presently being studied and is considered a major issue in establishing useful practices.

d. Material development is the determination of content of materials to be reduced to a microform and made available where needed. Here is the decision as to what material will be recorded, whether the material will be a single item or a part of a collection of related materials, whether it will be assembled into a subject-related series, or a chronology, or some other sequence of particular utility,

in whole or in part. Establishment of content of microforms may involve completely reordering materials as they appear in a hardcopy form, and presenting them in some new way which takes advantage of the particular values of a microform to be used, and of the specific purpose to be served.

e. Production of microforms involves filming, developing, duplicating, and some distributing. As part of the production process, the editing, indexing, coding, and accession controls necessary to the microforms must be considered.

Reduction ratio of a microform is the number of times the material is photographically reduced in relation to the original material. A standard reduction ratio is 20-to-1 (or 20X, meaning 20-times reduction) which has been the standard established by the Committee for Scientific and Technical Information (COSATI). (In this instance, an information area originally 8.0 inches by 10.0 inches would appear in microform as an area 0.4 inch by 0.5 inch.) This U.S. Government standard is extensively used for 4 × 6-inch microfiche report literature where 60 images appear in 5 rows of 12 each. Another much-used reduction ratio is 24-to-1 presenting 90 images in 6 rows of 15 each, as established for 4 × 6-inch microfiche by the National Microfilm Association (NMA).* As newer films and equipment are developed, greater reduction ratios are possible and are being used. More material is becoming available at 40X and 42X on 8-millimeter film; computer output microfilm (COM) will appear at both 20X and 40X (approximately).

* The COSATI standard was revised in May 1971 to be consistent with the NMA standard at 24-times reduction.

The very high reduction ratios, 100X, 150X, 200X permit the consolidation of a great deal of information into a small film area and permit a single book to a single fiche, or many related information bits to a single fiche.

Projection ratios must coincide reasonably well with reduction ratios in order that microforms may be read on a viewer screen: however, an image might be reduced at 20-to-1 and be projected back onto a screen at 30-to-1 so that the projected image was larger than the original. This is known as positive blowback. If the image were projected in a size smaller than the original it would be projected at a negative blowback. The same material might be projected at the same ratio as that at which it was reduced for normal viewing purposes, and at a positive blowback for other reasons such as for viewing by persons with impaired vision.

Readability of a microform image has to do with the quality of the materials and equipment, in combination, that is necessary so that an individual can read the projected material in context. Quality of the image is not as stringent for "readability" as it is for "visibility" which has to do with positive identification of individual symbols and characters on a viewer screen. For numerals, symbols, tables, graphs, and any materials where individual characters are important to communication, "visibility" is the mandatory criterion. For narrative materials, "readability" is the essential criterion.

Generations are ascribed to microform copies. The original silver film exposed to develop a microform from a hardcopy or other source, is a first generation negative. The positive film produced from this original master is a second generation positive. The next film made from the positive is a third generation negative, and so on.

In the case of COM (computer output microfilm), the first generation from the computer output is a positive. Multiple film copies can be made from any of these generations, but with each generation some resolution is lost. In producing a microform of any particular reduction ratio, the full reduction can be accomplished in several steps rather than in a single step; for instance, 100X film may be produced by reducing the original source material to a film at 10X, then producing a positive intermediate, which is again photographed at 10X, thereby producing a final master at 100X. Up to about 50X, at the present time, reduction can be accomplished in a single step; beyond that, the two-step process is currently employed. However, even for low reduction microforms, it may be desirable to employ a two-step process to produce the particular microform desired.

Copyright is a problem in microform development as with the copying of any copyrighted material. Fair use prevails, of course, and users must be aware of its applications and its limitations. The entire problem of copyright as it relates to present copying techniques is under study and new legal guidelines can be expected as time passes. In order that existing information may be utilized, some new systems of permissions or licensing are being studied.

f. Film formats and film design should be determined in accordance with the planned use of a particular class of information, in the same manner that the decisions as to reduction ratio and type of microform are determined. Use is the controlling factor in all decisions: greater facility in utilization of information is the goal in the development of any segment of microform application. Mere substitution of a less expensive medium is not the sole justification for selection of a microform; it should be responsive to the user to the same degree,

at least, as the medium to which he has become accustomed. Microforms have the potential for greatly facilitating information exchange when properly employed and formats play a major role in overcoming machine interference in the communications process.

Continuity of microforms must be considered in planning materials. With roll film, the roll of a particular film length is the information unit and materials which are held in this fashion must be appropriately described and indexed. The roll film is particularly useful for serialized material such as newspapers and periodicals which lend themselves to access thru their chronology and special indexes. With other types of material, the information unit must be determined, and a best form selected for it. Report literature, being most often of minimal length, can be well handled with microfiche in the COSATI (20X) or NMA (24X) format. Book-length materials to be read sequentially from beginning to end lend themselves to a presentation on roll film which can hold an entire book as a unit, or on microfiche of a reduction ratio sufficiently high to permit one card to hold one book. For other materials, such as educational materials, workbooks, and learning guides, the fiche form provides the most flexibility, and the reduction ratio to be used should be determined by the task to be performed. In some instances, the continuity of materials, and the unit to be retained, may be a departure from that previously accepted; chapters from books may become units rather than the book itself; another departure might be the collection of a series of articles from periodicals with each article a unit rather than the periodicals themselves. In all such cases, in-depth indexing and access controls are mandatory.

Polarity describes the readable image as to light reflected or transmitted; the positive polarity is true to life, whereas the negative polarity reverses the situation so that normally white areas or symbols are dark and the formerly dark are light. The use situation determines which polarity is most appropriate for a particular piece of material; different kinds of viewers respond differently to positive and to negative polarity; the magnification ratio of lenses delivers light to the screer in different ways so that the individual user responds to the light from positive and negative images differently under different circumstances. Ambient lighting in use environments is a factor to be considered in deciding upon which polarity to use. The material itself, with graphs or photographs, may be best presented in positive, or negative, or a mixture of the two.

Color in microforms may become more broadly useful as development of new films come to pass. Aside from aesthetic considerations, color is an important tool in communications. Color codes and color cues contribute to information transfer and speed of identification. As this area of microform production is more sophisticated, there are problems to be solved relating to true color representation where this is vital, copying of colored microforms, film resolution limitations, and costs. However, color should be included as a consideration in the formatting of material for presentation of certain types of information.

Changes in material content may be in order. In developing microforms from already existing material, decisions must be made early as to whether the task will be one of merely copying material already available onto a microform, thereby providing a substitute for the hardcopy original, or whether the microform will be a new edition in which changes have been made in content or arrangement. It may be

that additional information should be included with the old, and, therefore, the microform "copy" will be an expansion or editorialized version of a former publication.

Sequence of images, or direction of image placement on microforms is important in the reading of information. Original roll film has utilized two image progression sequences, the comic, which is a horizontal row of images as in a comic strip, and the cine, which is a vertical column of images as in cinema or movie film. An open book, to which users are accustomed from early training, is developed in the comic mode, with a left-hand page and right-hand page, and on to the end. Certain old scrolls are in the cine mode and read vertically from one end to the other continuously without a break. In the comic or horizontal progression of images, each page of material must be brought into alignment on a viewer screen in order that it may be read; with the vertical progression of images, the user can continue from the bottom of one page to the top of the next without losing eye contact on the viewer screen. The end use of the material must determine which progression to utilize; where images should be kept distinctly separate, the comic progression accomplishes this; where material should be read without break, the cine or vertical progression of the material serves this purpose.

Variable progression can be achieved with microfiche. In formatting material, it should be kept in mind that microform in sheet or card form presents the designer with an opportunity to develop materials which can be used in more dimensions than is possible with a book or with roll film. The user can progress through the material forward, backward, up, down, to the right, to the left, diagonally, or along some complicated map or route that the designer brings to bear

in presenting his material. This multi-dimensional aspect of material presentation can be greatly exploited with the microfiche of high density. When color as a code is added to this situation, the possibilities of utilizing the multi-dimensional capability of microfiche for individualized and programmed learning are evident.

g. Documentation of content is essential. No matter in what medium or form information is developed, it must be well documented for access and retrieval or it is essentially worthless. Great concern is currently expressed on the part of information users as to the development of quantities of microforms which may be difficult to retrieve and utilize because of inadequate bibliographic controls. The materials themselves, as well as all associated containers and receptacles, must be carefully handled in this respect. Useful information is expected soon to help publishers with this important problem. In addition to adequate bibliographic access tools to retrieve filmed information units, the microforms themselves must be designed with internal accession aids that are functional and simple to utilize.

h. Standards for microforms are minimal at this time due to the current expansion of the industry into new and untried avenues which could bring decided advancements to the user of microinformation. The Government standard COSATI is well known, as is the NMA standard. However, it can be expected that 8-millimeter imagery (or 40X reductions) will become plentiful since the computer's COM utilizes this reduction ratio primarily. As some of the newer materials in higher densities prove their utility, standards will undoubtedly be adopted with respect to them. Knowledgeable individuals foresee a family of standards for different kinds of microforms, rather than the selection of a single type and density to perform all tasks in a

compromised manner: different forms will be used for the specific communication for which they provide the most suitable and useful presentation in a specific environment. The users of microforms will have much to say about these standards in the future, their input being in the form of acceptance, endorsement, purchase, and use of particularly well-designed and applicable materials.

i. Information stores, bodies of materials which are being developed and will be available for use in many ways and through many channels, on site and remotely, are increasing rapidly; much of this information is held in the newer mediums, electronic tapes, computer memory, and on various films. Data banks of many kinds, covering a wide range of topics and statistical information, are becoming a major resource which can be utilized by an ever-increasing audience. In many cases, the computer can be used to manipulate information and provide the management for data which is held in film storage. Retrieval of film records can be accomplished by the computer and with sophisticated mechanical and electronic retrieval systems. Information is being developed and stored by government at all levels, industry, news media, banks, innumerable agencies, professional organizations, and educational institutions.

2. Projection Equipment for Individual Users

a. Viewers or readers are optical machines which utilize lenses, mirrors, and screens to magnify information held on microforms and present it to a user in a size sufficiently large to be read by the human eye. Many different reading machines are available, of varying size and configuration, and the development and manufacture of new types is proceeding at a rapid pace. Viewers in the past have been primarily of a stationary type, upright and heavy, so that they

might be considered to function almost exclusively in an institutional setting, serving a precisely defined purpose. Now, the need for a more personal, and therefore portable, viewer has been recognized and manufacturers are developing smaller and lighter pieces of equipment for reading microforms. The formats for microforms in the past, being almost exclusively the copying of already designed printed pages of information, have required that reading machines be constructed with long optical paths to recreate for the user the page that was developed via the printing press. With modification in material presentation, whether new material or old material that has been redesigned for microform presentation, smaller personal viewers are possible. Statistical information concerning different viewers is available from several sources, including the American Library Association. Literature from manufacturers is helpful. However, it is best to determine microform equipment capability *in situ* since many local environmental conditions contribute to the functioning of these machines, and a best fit cannot currently be made from statistical information alone. Equipment for viewing microforms presents an image to the user through projection of an image onto a screen. Some viewers project this image onto the back of a translucent screen; this type is a rear projection viewer. Other readers project the microform image onto an opaque surface or screen; this type is a front projection viewer.

Although machine parts, as they confront a user, should be kept to an absolute minimum to lessen machine interference with communications, viewers must be understood in terms of their basic components in order that they be less threatening. There must be a smoothly functioning system to hold the microform firmly in precise

position to be presented to the user. There must be a good and adequate lens to magnify the image; if more than one magnification is possible with a single viewer, then the different lenses should be easily brought into position for use. A system of mirrors which transport the magnified image from the lens must be held firmly in position to keep the image from being distorted. The screen which confronts the user should be clean, clear, and unmarred. A lamp of proper type and wattage is needed to force the microimage through the system of lens and mirrors and onto the screen with sifficient contrast to be readable. The intensity of the light is dependent upon the degree of magnification that must be achieved, high reduction ratios requiring the concentration of a great deal of light onto a small film area. Since lights generate heat, where a great deal of light is required it must be dissipated from the film by the use of fans. These can be a source of distracting noise unless well designed. As the image appears on the screen, it must be precisely focused by the user and the focusing controls should be readily accessible and smoothly functioning. The entire viewer system should be precisely engineered to the end that the screen is equally bright overall, the image is not distorted, and the focus once adjusted for a piece of film does not need readjustment as the task progresses.

b. Copying machines are often required to produce hardcopy from a microform. This requirement may be lessened in the future when more viewing equipment is available for use by additional people. However, even with the advent of many viewers, hardcopies will be required for some purposes. Machines which make paper copies of microform images are viewer-printers, primarily. These pieces of equipment are slightly larger than conventional institutional viewers, and they are more expensive. The copies produced are priced per page

since they require a special photographic paper for their production. Other hardcopy machines for microforms are not viewer-printers but simply copying machines; these pieces of equipment are bulky and strictly production oriented. Still other copying machines developed for microforms provide not hardcopy but duplicate films. Large processing installations perform this function for the most part but, in addition, small pieces of equipment are becoming available particularly for the duplication of microfiche. With such equipment, dispensing of film duplicates from a central storage area would be much less expensive and less time-consuming, as well as simpler, than the making of hardcopy; however, this practice assumes that viewing equipment is plentifully dispersed as well.

c. Integrated carrels are work stations which integrate equipment and work surfaces, as well as essential materials, into a single configuration for a particular function. Integrated viewer carrels for an educational task would provide a microform viewer, writing surface, space for hardcopy materials, files or shelves for microforms, localized lighting systems and power, and all required materials and equipment for an educational reading and study task in a single integrated location. The same type of development could be brought to bear on an industrial task so that the local use environment would contain all elements for the task to be accomplished in a functionally designed, integrated module.

d. Maintenance must be accomplished continuously and well. Film materials must be treated with respect and maintained in clean, orderly arrangement under conditions promoting a long and useful life. Institutional maintenance of microform equipment must be undertaken by adequately trained technicians so that viewers are useable at all

times. Inasmuch as the information needed on an individual's microform is actually in his hand, his inability to read it because of viewer failure is devastating; it's like an itch that he can't scratch. Equipment dealers should provide prompt servicing of their products when they malfunction, but users should be sufficiently educated in minimal maintenance to keep their equipment operating under normal conditions. Here, the simplification of equipment looking to maximum individual user maintenance might be expected to increase acceptance of the microform medium through increased equipment availability.

C. History of Microfilm

Microfilm was developed about 1839 so that it has been available for 130 years. Not a great deal was done with it, in the sense of mass communications, however, until World War II. At that time it was used to transmit a great deal of information overseas by plane. A use for film was developed by the motion picture industry several generations past, and much of the progress in microfilm technology resulted from this cinema use. In the 1920's a need was felt to record bank checks and microfilm was adapted to that requirement. Following World War II there was a requirement to reduce much of the documentation that had been developed in connection with the war effort to less costly storage, so microfilm was utilized for that purpose. The aperture card was developed for engineering drawings in the late 1940's. Now, the amount of information being accumulated in written form is so great that the use of film is essential. The computer has greatly increased data output so that institutions are deluged with paper. The use of film, properly indexed and retrievable, can preserve essential written materials for future use. For information on the early

development of microfilm, see F. Luther's Microfilm: A History, 1839-1900, published in 1959 by the National Microfilm Association, Annapolis, Maryland.

D. Applications and Acceptance

1. Conceptions of Use

Use potential for microforms is as broad as information use in general; applications can be considered almost endless and only a few have been actually practiced. Difficulties in use have been glaringly evident, but have arisen to a great extent from the fact that microforms have been created to serve one purpose and then been asked to serve another. Microforms which were merely film copies of old materials, produced to preserve the information contained in deteriorating texts, and held in storage often with inadequate indexing or access controls, and then recreated for a user on little understood and poorly maintained pieces of equipment, usually difficult to focus and adjust, did little to encourage users. This type of microform application was developed for preservation and storage of materials and not for active use. As the need for routine use of microimagery increases due to the amount of information being created, the type of material to be placed on microform is changing from the old microform concept to a new and dynamic concept; microform will no longer be a dead storage medium but rather will be a working tool for information transfer: it will no longer be a substitute for hardcopy materials but will be a routine communications medium. Since the capability of microform is different from that of books and paper, the format for information storage and use can change with the microform's different potential. Microforms can bring graphic and visual presentations into more active use along with the written word because of the storage capacity of microform units, and

may be able to play a dynamic role in conjunction with other media such as sound in an instructional setting.

2. Selection of Form

The particular microform to be selected for material development must be keyed to a particular application. The unit of information must be considered, whether long or short, the kind of viewing equipment that would be most appropriate in the use environment, whether the information is developed in a natural chronology or by subject segments, and all factors that can be identified as specific to the particular use situation. When this has been done, a best fit can be determined as to the type of microform to be developed for that material and that application.

3. Unique Benefits of Microforms

Many of the benefits of microform have long been recognized, such as reducing publications costs, publishing on demand, and greatly reduced storage requirements. More recently recognized benefits include automatic retrieval of information, enhanced coding and indexing via microforms, variable unitization of material content, and the multi-dimensional capability of sheet film, along with possibilities suggested for color coding of information avenues or blocks. Along with possible benefits, restrictions of present microform materials, systems, and equipment are being identified from a user orientation so that the benefits can be exploited while impact of machine restrictions are minimized.

4. Problem Areas

As use of microforms increases, refinements in materials and equipment are necessary to serve a broader base of users with routine

requirements for information of varying kinds and in differing environments. When a large number of people use the medium routinely, restrictions are readily identified. In the past, attention has been focused upon the technology of films, production and processing, and equipment parts and capabilities, with little emphasis on the user and his environment; the technical capability has been developed but the matching of the technology to the user himself has been little studied. Currently, researchers are studying the microform user to better fulfill his requirements and have found that he has much to contribute to the design of materials, systems, and equipment that he will be required to utilize as microforms proliferate. Identifiable problems are the disorientation experienced by a user between an upright screen presentation and a working surface when he is performing a task involving both of these areas. Orientation within the material itself, as presented on a screen, requires guides and indexing to aid the user in establishing references to the whole body of the material with which he is involved, and these are often inadequate. Dependable focusing within frames of material and from frame to frame is often not achieved with available equipment. Fatigue from uneven screen illumination is always a problem and dizziness can be experienced when images are moved across the viewer screen during a search task. Cooling fans can prove to be extremely annoying, and in a classroom they can compete with the instructor. The space occupied by equipment can leave little working space for a user unless planned for in advance. Individualized markings on microforms is a problem, as is the integration of new material or updating of information. Sophistication of systems and equipment are formidable to the uninitiated, and equipment failure can leave the user helpless to achieve a desired communication since alternatives have not been established. Such problems are attendant

upon a change from commercial applications to educational applications; from reference tasks which are generally specific, search-oriented, and short-lived, to study tasks where students must use the presentation for long periods of time. The user in a commercial situation is highly motivated due to his employment and the nature of the tasks performed; the user in the educational environment must find his own motivation to perform the long-term tasks which are inherent in his educational activity.

5. Acceptance

It is necessary that microforms satisfy the user's information requirements to be acceptable to him. He does not want to expend more effort in using a microform than he has been required to expend with other media in the past. The total microform system, materials development, accessibility, and machine delivery of information, must be so well designed that the user is assisted in gaining information rather than hampered by having to use microforms. The benefits to be derived from the system's use must be exploited to make it valuable to the user as a satisfactory communications medium, and when he feels that he gets more from the microform system than he loses by having to use a machine in order to read, the medium will be acceptable.

E. New Techniques and Processes Related to Microforms

Of particular interest at this time is the production of microforms via the computer. COM is "computer output microfilming" whereby output from the computer, whether from computations or as a result of programming a piece of textual material, or the scribing of a computed graph or chart, can be filmed directly within the computer by means of a cathode-ray tube and a camera which is pointed at the face of the tube. Since this operation is very fast, being limited at

this time only by the speed of the film employed for recording the computer output, it is extremely important to the total microform effort. Less fully developed at this time is CIM, "computer input microfilming" whereby microfilm is used as input to the computer for manipulation of the information presently held on film. When this is more fully operational, film records will be used both as input and as output with computers for speed and greater storage capability. Another new development is OCR, "optical character recognition" which is machine-reading of information in eye-legible form. This, like CIM, is still in developmental stages. Equipment for the automatic retrieval of the physical films, roll or fiche, is being developed, along with equipment for display of the information on viewing screens and return of the microforms to storage. These systems are expected to be utilized in the future along with computer searches for relevant materials for a particular information requirement. Some new equipment has been developed which combines a roll film-fiche concept, whereby fiche with its multiple frames of information is contained within the equipment in a continuous roll for search and display. As requirements are identified, and needs specifically expressed, the technology relating to microforms is sufficiently developed to be responsive. Of importance in the use of microforms is the development of total information systems where microforms are to be utilized so that all of the elements which interact assist in the ultimate purpose of providing the user with needed communications. Such total systems are being developed in a number of areas and more will be achieved, directly through study of requirements and deliberate application, and indirectly through trial and error as use of microforms proceeds at an accelerated rate.

F Costs

The costs associated with the development of materials for microform and the equipment for their use is variable depending upon the terms of application. If microform materials are created simply by filming existing hardcopy materials, and institutional-type, free-standing viewers are employed for presentation of materials, the greatest cost involves the original filming of the material and the price of the viewing equipment. However, if materials are redesigned to take advantage of the benefits of the microform medium, costs will be incurred in this work; the payoff for the additional cost of preparation would have to be assayed against increased effectiveness of the presentation and any savings that accrue from this increased initial effort. In an institutional setting, the savings in space brought to bear by use of microforms as opposed to hardcopy materials must be considered in light of the space needed for reading equipment and its maintenance costs. If individual viewing equipment becomes widespread, however, information stores such as libraries can become involved in dispensing materials at very low cost as microform duplicates and save materially in operations associated with the lending of materials. The total system planned for microform use, involving the development of materials, their production, the storage and use environment, the equipment, and the operation and maintenance of the total system and its component parts, must all be costed to arrive at a relative figure when considering the implementation of an activity utilizing microforms as opposed to another medium.

G. Suggested Readings

The interested reader is directed to a listing at the close of this chapter which provides representative references to microform

technology. There are now continuing publications which deal exclusively with the subject, as well as many current references to microform developments in the literature associated with related disciplines such as librarianship, optics, equipment manufacturing, and films. Materials being generated in connection with the offerings of microform equipment manufacturers, and publishers, are valuable for indoctrination of the novice, and the information available is exceedingly plentiful. The references listed in this Guide serve only as an introduction to a vast amount of documentation on this subject.

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CHAPTER II

MICROFORMS IN TRAINING APPLICATIONS

An examination of the applications of microforms in both industrial and educational settings leads to the conclusion that the microform medium has been fundamentally a display mechanism substituting for the original form of the information presented. As a display device it has certain unique and desirable characteristics, most of which center around its capability for high density, low cost, and easily packaged dissemination of information. In this section, the capabilities for alternate presentations with microform in a direct (non-resource) instructional mode are developed. This discussion is developed in particular for military training applications.

A. Military Training

1. Introduction

The considerations of a military training program must take into account both the deliberations of general educational programs, and those objectives peculiar to the military program and its special constraints and needs. These are specified in the various military training handbooks and may be summarized under the following headings:

1. The qualitative requirements of each plan of instruction. These are the specific task objectives of each training situation.

2. The special needs of a heterogeneous training population. In addition to attention to the wide variety in the individual backgrounds of trainees, instruction must be supplied in initial training, cross-training, and recycled training modes.

3. The minimization of cost/benefit ratio for preparation and delivery of instruction. To this is added a requirement for ease of update and correction, flexibility of use, problems of material storage and transmission, etc.

4. Modification of instruction according to constraints of a particular training environment, e.g., classroom or group sessions, field and laboratory applications, individual learning for remote areas, availability of trained instructors, etc., and further must be adaptable to the balance of the trainees program and military obligations, such as squadron duties, etc.

In summary, there exists in the field of military training a number of important and continuing needs which must be superimposed on a background of sound educational psychology.

2. Microform Medium and Military Training

It was out of such needs as these that some time during World War II a discipline which became known as human engineering developed. Human engineering is particularly concerned with ways of designing machines, operations, and work environments so that they match human capacities and limitations. It is concerned with the engineering of machines for human use and the engineering of human tasks for operating machines. Although directed toward this special learning application, acquisition of a motor skill, the body of military training literature is highly influenced by the human engineering approach, as is most educational literature originating during and after this period. As such, it has contributed much practical information about training instrumentation, but also has originated a science of human learning.

The introduction of the microform media into the planning and delivery of training presents a very special application of this educational approach in which man-machine interaction becomes a factor not only in the sense of teaching perception-motor performance, a common military objective, but also in the very method by which such training is delivered. The usefulness of a high density film card (fiche)

with its ability to reproduce the equivalent of 60-3000 pages, depending upon reduction ratio, in a compact readable form appears to be generally accepted in applications involving resource materials, when randor access to the filmed information is an important user consideration. This form of microimagery is vastly superior to the roll form for instructional applications because of the serial characteristics in the roll film imagery.[1]* However, before pursuing the applicability of the microfiche presentation in a more direct training situation, the basic human engineering question as posed by Smith and Smith (1966) had first to be paraphrased for this purpose: Can a machine of certain design be operated efficiently in an instructional milieu by a human individual, or does its technical design interfere with the normal patterr of human learning? Experimental studies have been devised to respond to this question. In one such study, Kottenstette (1969)[2] determined in a reading experiment that there are no fundamental physical or psychological barriers to the utilization of microforms via microfiche and viewer in the communication of narrative information that students customarily encounter in hardcopy. Studies such as the Baldwin and Bailey (1970)[3] on performance evaluation of technical training with microfiche vs. hardcopy substantiate these findings and add to the accumulating experimental data which had first to be examined before microform educational applications could be expanded from their role as substitution for hardcopy to their routine utilization as a new communication medium. Grausnick and Kottenstette (1970)[4] replicated the Baldwin and Bailey study in order to establish both the reproducibility of their results in a different user environment (Lowry Air Force Base) and to establish the reliability of the instruments they developed as

* Footnotes refer to the bibliography at the end of the chapter.

tools for future microfiche evaluations. [See "A Performance Evaluation: Microfiche versus Hardcopy" AFHRL-TR-71-42.]

Having accepted the microform medium as a potentially suitable vehicle for primary instructional materials, the associated questions of preparing the software and introducing the hardware-software package into the training programs become appropriate issues for discussion.

B. Training Software

1. Learning Theory

The preparation of instructional materials must follow those principles of learning applicable to instructional content and objectives, student needs, and training environment. A study of learning theory is as appropriate for the authors of filmed materials as it is for the writers of text, lecturers, and other participants in teaching-learning strategy, and in fact becomes more important as the potential number of presentation options is increased, as is the case with microfiche. No single theory or principle is likely to be adequate for all training applications, but dependable instructional procedures for achieving specific objectives are needed so that application of a variety of instructional methods is not haphazard, but is based upon careful matching of specific procedures with identified objectives. Useful summaries of learning theories are found in Stephens (1956) and Smith and Smith (1966).

General learning theories tend by their very nature to make little allowance for the highly specialized nature of human behavior organization. The human factors approach to training research, referred to earlier as human engineering, considers learning to be determined by the nature of the behaving individual as well as by the design of the learning situations. Continuous feedback from the learner into the ongoing training process has been redefined during the last few

years as "closed loop" or "behavioral cybernetics." In order to optimize information flow, a strategy must be developed for subject matter, student differences and circumstances with attention to what information, how much, how complex and what communication process is used.

2. Microfiche Materials

Translated into education objectives, stimulus-response theories of education lead to simple, stable, functional relationships in which the purpose of instruction is to establish relationships so that the presentation of a stimulus results in a desired response, which is then reinforced, generalized upon, and discriminated between or refined. Gestalt theories emphasize the value of presentation of new information, not in easily handled small steps, but as a simplified large and meaningful whole so that as specific bits of information are presented, they are assimilated into the greater information unit. Further, more latitude for student input and branching to material of interest to him is permitted, which although indirect at times, contributes ultimately to the learning objectives. The human engineering experiments caution instructors to pay sufficient attention to the individual trainee by giving him an opportunity for immediate and continuous feedback into the learning operation. Obviously, this is best handled through learning simulators for motor performance objectives, but the theory can be incorporated into instructional materials as well by providing uncomplicated alternatives for individual trainees which nonetheless lead them to desired outcomes. Finally, educators advise instructors to consider well the objectives of training and the maturity of the trainee when composing instructional materials according to any of these theories. The microfiche presentation can serve in each of these

areas if the following attributes of the film are incorporated in the fiche design as appropriate:

1. It presents frame by frame information units with question-response or optional reading alternatives until generalities are finally induced by the accumulation of examples and bits of information.

2. The fiche film card, with its capability for presenting strategically positioned associated information in text, tabular, and graphical form, aids in establishing a high level of student contact by allowing the trainee to deal with new information both verbally and non-verbally in an integrated way.

3. Each segment can contain sufficient material to illustrate and elucidate the central theme, from the most basic and elementary to quite advanced exemplars, thereby accommodating many levels of sophistication.

4. Each central concept can be approached from several directions: each converging on the concept and yet broadening the information base for further acquisition of concepts.

5. The student can work inductively by taking specifics and moving toward general concepts (as in 1) but the specifics are obtained by breaking concepts and principles into logical components and showing the relationship of the parts to the whole.

6. Each segment attempts to integrate the preceding segment to enable the student to combine the basic concepts to obtain other, more remote conclusions. The segments are interrelated in a specific manner to underscore the gestalt obtained in the specific area and to indicate the contribution of that concept to other areas.

7. Recognizable terminal points for each segment are identified and established, and the material is broken down into skill levels so

that the trainee can diagnose his own areas of deficiency and enter and leave subject matter at the level of his own choice, skipping known material, concentrating on the unknown, and proceeding at his own pace where possible.

8. The information units are designed with internally supported and integrated access tools: i.e., editorial comment, cross referencing, associated relevant material, etc.

9. Each unit can be quickly updated and easily modified to include particular or specialized approaches to a given concept.

a. Formatting. The potential of the microform as an instructional media can be achieved through formatting of microfiche. It is through formatting that microform can positively contribute to educational technology. The concept operative in the selection of a fiche format can be seen if the training materials are viewed, either as already existing, or alternatively as being under development. Formatting of existing training materials should be approached through an analysis of the training objective, and, by working backwards, the essential information to achieve that objective can be identified as to encounter sequence and relationship to other types of supporting documentation. For example, to create a format for the instruction of trouble-shooting procedure for a specific item of electronic equipment, it might be appropriate to begin a fiche sequence with a description of faults, a list of symptoms, a photograph of the appropriate subsystem, instruction for dis-assembly, a set of diagnostic procedures, and a schematic diagram. Associated materials might include a parts list, safety procedures, tools and test equipment required, circuit

performance parameters, and theory of operations. The relationships that are postulated are:

1. Symptoms and theory.
2. Dis-assembly, safety, and tools.
3. Diagnostic procedures, and test equipment.
4. Schematic and circuit performance parameters.
5. Schematic and parts lists.

A combination of vertical (columnar) organization of the trouble-shooting elements, together with a horizontal (row) organization of related information elements could be an extremely effective fiche format. The fiche should include the appropriate redundancy, examples, and explanation if these materials contribute to the completeness of the desired communication.

This strategy can be developed in the following way. The parameters which are keyed to the nature of the instructional information can be manipulated to identify systematic differences in the film format.

These parameters are:

a. Content of the Material Itself. Should additions or deletions be made, or should the original material be held intact for microform presentation?

b. Film Input. Should the original copy of the material be filmed, or should the material be composed or programmed (reorganized internally in each frame) differently for greater effectiveness?

c. Directional Format. Should the presentation be organized horizontally, vertically, or mapped?

d. Image Arrangement. Should the film images be presented sequentially or otherwise related for greater effectiveness?

If the reduction ratio, image polarity, film size, and unitization considerations are ignored, then a matrix of formatting possibilities emerges as a result of the various combinations of parameters. The table below summarizes these format possibilities and they are diagrammed in Figure 1.

Table I. Parameters for Microfiche Formats

Parameters Considered		1	2
A	Content of Material	No Change	Changes
B	Film Input	Fixed	Programmed
C	Directional Format	Horizontal	Vertical
D	Material Arrangement	Sequential	Related

In structuring a fiche presentation, the lesson designer makes several decisions with respect to sequencing instruction. After deciding in what order to present concepts and subconcepts of the subject matter, he decides whether these concepts are to be presented as rules or as examples for which trainees are led to the guided discovery of rules, and finally a sequence is determined for permitting an individual to test himself and to choose alternative sequencing--more and different explanation, explicit testing, self motivated and more unstructured reading. According to the results of Gagne and Brown (1961) and Krumboltz and Yabroff (1965) there was no significant difference in achievement attributable to inductive and deductive learning

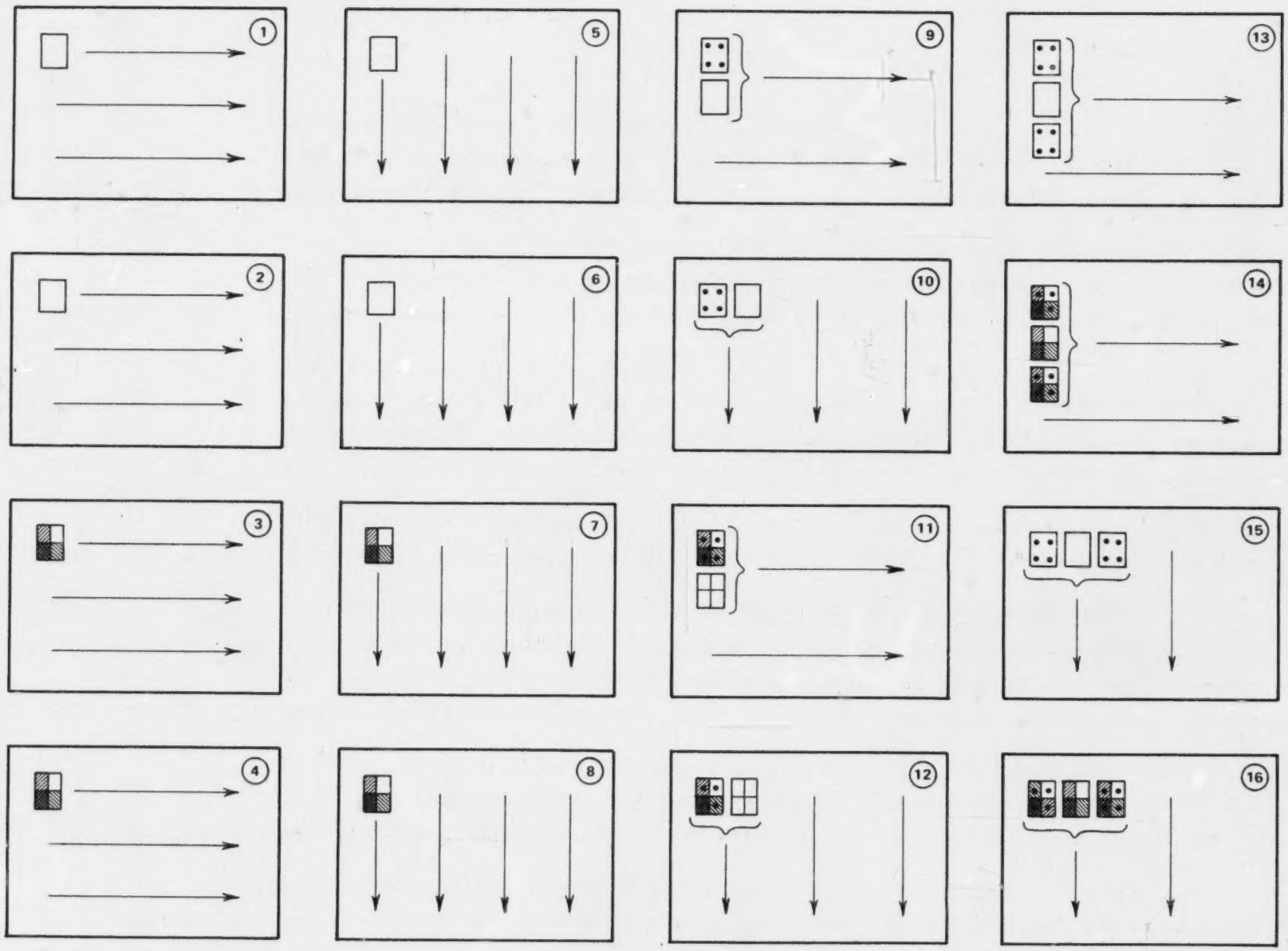


Figure 1. MICROFICHE FORMATS - Ignoring: Reduction Ratio, Polarity, Film Size and Unitization

Format Key*	Description
1. A1, B1, C1, D1	This is the Standard COSATI presentation. (Merely copying onto film)
2. A2, B1, C1, D1	Presentation by Standard COSATI format, but material has been altered by making editorial changes (material reworked before filming).
3. A1, B2, C1, D1	Material has not been altered editorially, but the information has been programmed to appear on the screen in a more meaningful way. Each presentation, or the total material, is set-up for communication impact.
4. A2, B2, C1, D1	Material has been editorialized for a particular purpose, and, in addition, the material has been programmed to appear in a meaningful way through judicious placement of segments or parts. Single presentations or entire sequences may be programmed alike or in variable fashion.
5. A1, B1, C2, D1	The only change here from the Standard COASTI presentation is that the material is posted to the fiche in a vertical sequence. (No other changes)
6. A2, B1, C2, D1	The material is presented vertically and has been edited for some purpose. (Since editing requires re-printing, selection of type styles, sizes, image areas, and the like, can be used to ensure a more readable screen presentation.)
7. A1, B2, C2, D1	Vertical presentation that has been programmed for most suitable presentation insofar as the actual material being viewed is concerned. Single images or entire sequences programmed, alike, or in variable fashion.
8. A2, B2, C2, D1	Material has been editorialized for a particular purpose and the material has been programmed to appear in a meaningful way on the screen; the presentations are sequenced vertically.

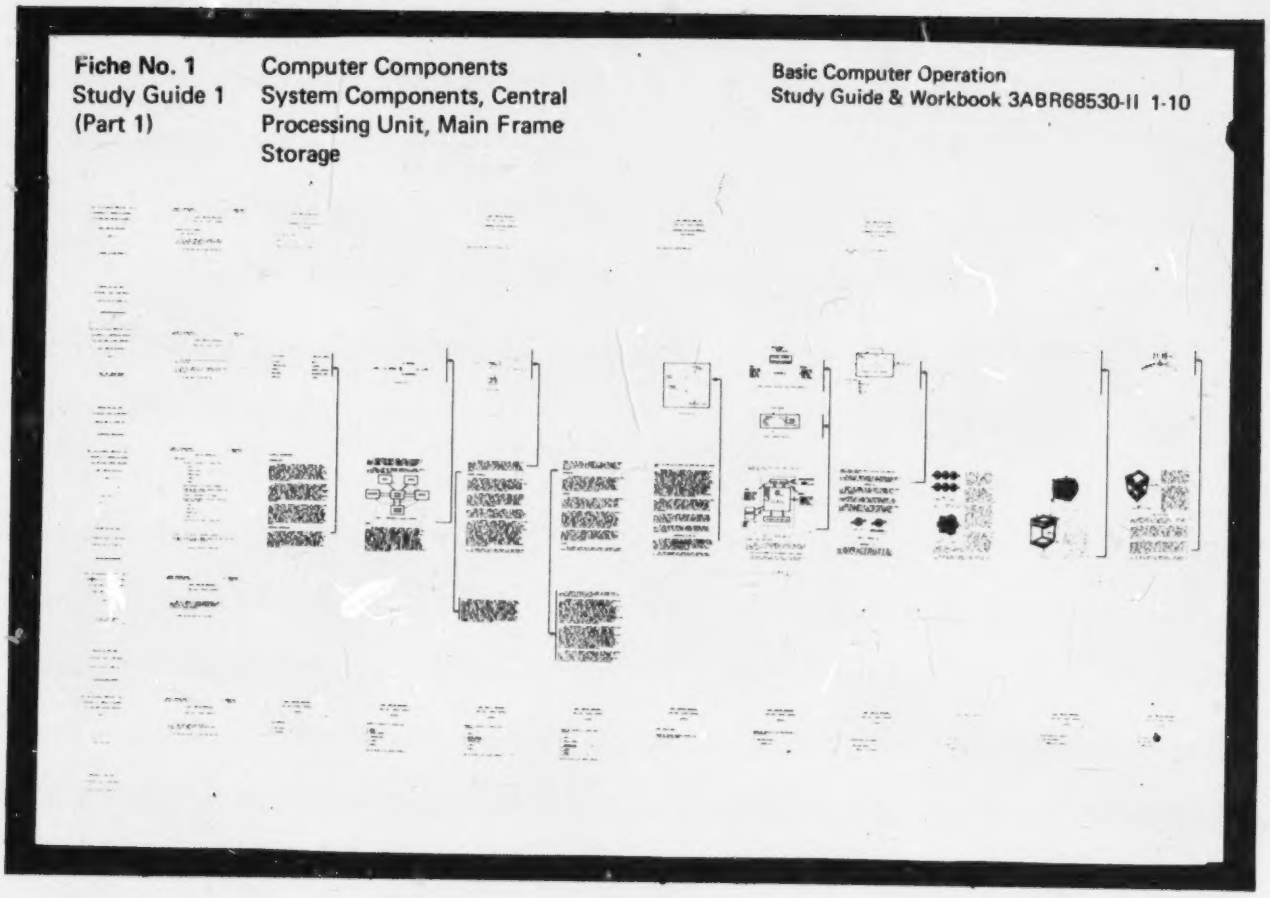
* See Table I

Format Key	Description
9. A1, B1, C1, D2	Here the material is presented sequentially in a horizontal fashion, but more than a single row is used for the sequence. Examples, illustrations, redundancies, are separated from the main text onto an adjacent row, and each such item is placed on the adjacent row in the column which relates the item to its reference in the main text. The effect of this arrangement is presentation of text by row, with auxiliary material by column.
10. A1, B1, C2, D2	This presentation is sequential in a vertical fashion, using more than one column for the sequence. Examples, illustrations, redundancies are separated from the main text onto an adjacent column, each such item being related to the main text in the row which relates the item to its reference in the main text. (Presentation by column, auxiliary material by row.)
11. A1, B2, C1, [illegible]	The sequence of material on the fiche is horizontal. The main text is separated from the graphics, redundancies, and examplar materials which appear on an adjacent row (related to the main text by column). The input material is programmed, for the main text, for the auxiliary material, or for both, in order to ensure a most meaningful presentation.
12. A1, B2, C2, D2	The sequence of material on the fiche is vertical. The main text is presented in one column while illustrations and other additional materials appear in an adjacent column which relates this material to the main text by row. The material is programmed to develop the most meaningful placement of material for maximum communication.
13. A2, B1, C1, D2	In this format, both editorial changes and major material changes are involved, so that a body of related materials is presented supplementing the main text. The main text is reworked and appears sequentially in a horizontal mode, with the related materials falling in other rows which relate to the main text by the column in which they appear. The material in this presentation assumes a grid, with main text running horizontally, and auxiliary material appearing vertically.

Format Key	Description
14. A2, B2, C1, D2	To fully exploit the medium's capacity to relate materials, not only are columns and rows used to relate main text and supplementary materials, but the single image presentation is programmed for best placement of materials on the screen, for the main text and for the supplementary materials. This presentation incorporates, horizontal sequence of materials, changes and additions, and programmed input.
15. A2, B1, C2, D2	This form develops all the same components as No. 13, except that the main text is sequenced by column rather than by row and the supplementary materials are placed on adjacent columns, relating supplementary items to the main text by row. This form has editorial and major changes in materials, vertical sequence of material placement, more than one column used to present sequence of material.
16. A2, B2, C2, D2	This format follows the pattern of No. 14, except that the material is presented vertically rather than horizontally. Editorial changes have been made and major changes in the material have been incorporated into the presentation. The main text falls on a column which is bounded by supplementary materials related to the main text by the rows in which they are placed. Here, too, the input has been programmed for the most advantageous placement of materials within single image areas to exploit the greatest degree of communication from the composite of single images and those falling on the borders of the main text.

strategies utilizing example before rule, and rule and then example, respectively. The system of format identification presented in Figure 1 can then be applied to the enumerated relationships as postulated in the example on page 47, the instructional parameters identified on page 47 and the learning guidelines referred to in this chapter.

Format Example. The nature of the fiche medium, with its capability for display of information in both lateral and longitudinal directions, presents alternatives to the author-instructor which are in addition to the options available to the writer of workbook materials. This two-dimensional capability for adjacently placed material requires decisions regarding identification of instructional purpose and content and the organization of such materials to take advantage of the increased opportunity for strategic separation from straight main text information. For most applications some basic expository information can be identified as essential for the mastery of specific objectives. As one reads through most texts, other information appears to be for the purpose of elucidation--such materials may be in the form of examples, e.g., numerical or case history, or graphical illustrations, or re-explanations with review and references for review. Other information classes may be non-essential to the mastery of specific objectives but provide relevant topical information for the student whose personal interest needs are in excess of his training objectives. A fiche format developed to motivate, interest, and instruct the average and the not so average student alike is illustrated in Figure 2. This design corresponds to combinations A2, B1, C1, D2; Number 13 in Figure 1. The main line text here appears as the third row (horizontal) of the fiche film and is read from left to right. Other formats could show material located by column for somewhat easier tracking on the fiche viewer. The horizontal path shown here with the COSATI standard fiche takes advantage



● LOAD

					WORKBOOK AND REVIEW PROBLEMS						
1	2	3	4	5	6	7	8	9	10	11	12
					ADDITIONAL EXPLANATION						
1	2	3	4	5	6	7	8	9	10	11	12
					MAIN TEXT						
1	2	3	4	5	6	7	8	9	10	11	12
					NICE TO KNOW MATERIAL						
1	2	3	4	5	6	7	8	9	10	11	12
					OUTLINE						
1	2	3	4	5	6	7	8	9	10	11	12

Figure 2. An Example of Fiche Formatting to Enhance Instructional Communication

of the 12 frame capability of the row as compared to the 5 or 6 frame vertical capability. Directly above the main line text are located optional readings in the form of examples and illustrations as described earlier for the trainee who is not certain of his grasp of the material. He is informed of the availability of such material by properly placed lines and arrows in his main text, and he elects to use or not use this added feature. Directly below the main line text and associated with each of the frames is selected relevant materials non-essential to the objectives but of interest to the more motivated student, and motivating to the casually interested student. He is similarly informed of the presence of this material by lines and arrows. There are two other information categories required by the trainee to utilize his materials efficiently: (1) an outline of content and (2) workbook and review problems to test his mastery of concepts and skills. The first of these, the outline, is shown along the fifth or bottom row of the fiche. The student scans this row until he reaches the subject information of interest to him. By moving only vertically from this location to the third row, main text, he will find the information described in the outline. His workbook and review problems are located along the first or top row of the fiche. These appear above the text explanation they most relate to, so that if a student wants to check his methodology or to review the explanation needed for a particular problem, he can encounter the relevant information by moving one or two frames below the problem frame. The outline is provided as an extra study help of particular value to a fiche presentation itself. This whole concept of vertically relating complementary materials is to provide options for individual students, to encourage the broadening of an information base and the integration of concepts, to discourage unnecessary and

dysfunctional repetition of explanation, and to promote self diagnosis of areas of deficiency with provision for self-help. See "Microform Use in a Technical Training Environment -- An Experiment," AFHRL-TR-71-43, for more detail.

b. Colored Microfiche. Almost all of the instructional materials utilizing microfiche developed to date have been in black and white, either with a positive or negative image. Microfiche can be developed using colors as either background or print, and there is developing research to indicate that there is some justification, apart from the pleasing quality of the use of color, to justify the additional expense of colored fiche.

There are, in general, two principle uses of color: color when it is intrinsic to the material, e.g., nature study, anatomy, art, interior design, etc., and color as a cue. In this latter category, color is used to dramatize or focus attention on some important or summary concepts. This is of particular importance with microfiche since the user has no opportunity to mark or underline his copy, and requires some designed-in mechanisms for highlighting. A recent study on color coding[7] illustrates the usefulness of color grouping as a memory device. In this study, students were required to memorize the names of some of the bones in the human skeleton. Bones were classified and shown according to shape, with different colors indicating the shape classifications. Color clues given early in the memory task were shown to be of advantage in recalling the classification. Perhaps the most important use of color is the increased capability it gives for visual separation. Color detail in schematics and other technical graphics give increased clarity to the specific working part being described and to the manner in which that part fits into the whole.

Similarly, color separation makes the part easier to locate and identify. Color provides interest, force and contrast as well as an additional learning clue.

c. Media Mix and Instructional Microfiche. Although the microfiche medium presents a useful instructional alternative when used as a primary source of training material, it may serve equally well for certain applications, as an adjunct source of instruction. Some current research in educational technology points to the desirability of fiche-audio systems, computer-managed fiche presentations, and computer assisted instruction with microfiche resource. The increased cost of development and presentation of coordinated materials with computer utilization influences the selection of multi-media. Many of these methods are in prototype development stages, and although the rationale for their use is educationally exciting, cost benefit analyses of each of these systems of instruction will probably precede their widespread use.

d. Fiche-Audio Systems. An example of work in lesson material preparation using microfiche cards with audio is the work being done at the Lincoln Laboratory Educational Technology Program. The Lincoln Training System (LTS) carries lesson material on microfiche cards containing 192 frames each of visual material and an equal number of audio frames. Each lesson frame contains four elements: audio, visual, control, and lesson code. A small monitoring computer is said to be able to accumulate records for a whole classroom of terminals. Control information is extracted from each frame photo-electrically as the frames are projected for viewing. The rationale

for the development of this very complicated sound-slide system is given in the Quarterly Technical Summary from Lincoln Lab, December 1970.

> "Use of the LTS has at least two advantages over use of conventional materials for programmed instruction: (1) audio presentation, and (2) automatic student monitoring. An audio channel permits verbal instruction for those who, for whatever reason, listen better than they read. In the class with self-paced instruction, the instructor faces the problem of keeping track of the progress and problems of many trainees. This is a very real problem and some form of computer managed instruction (CMI) is required. The use of a machine like the LTS makes real time CMI economical and easy to achieve."

c. Computer Managed Fiche Instruction. Although the LTS machine has some of the control features of computer managed instruction (record-keeping), all printed instruction comes to the trainee via the fiche. A well developed CMI system supplies a whole mosaic of learning media experiences, some of which might be redundant. CMI meets some of the requirements of human engineering as well as other contemporary learning experiences by regulating not only content and skill level, but the instructional medium as well, to the learner. Computer terminal contact with students is often reserved for initial determination of suitable courses, recommendations for resources (microforms, programmed texts, films, etc.) for diagnostics and for testing. The information retrieval features of such a system work much as the LTS control system in the record-keeping and reporting capacity. Among the reasons for selecting the multi-media approach

is the recognition of the visual literacy and sophistication of most young people. With CMI, microfiche can be used as a substitute for hardcopy in providing convenient and immediate access to varied resources, or it can be used in any of its instructional formats as a primary teaching aid, depending upon the nature of the task, the availability of other resources, and the sophistication of the computer programmer in designing the complementary system.

f. Computer Instruction and Microfiche. Another alternative utilizes the instructional capabilities of the computer as well as of the microfiche. Computer assisted instruction (CAI) is well suited to the theories of programmed instruction. Automated programmed instruction such as CAI facilitates material presentation and accomplishes the necessary switching and branching automatically via remote computer consoles or teletypes giving the process more continuity.

The advantages of CAI include the convenience of learning during highly motivated moments, a more individualized approach to review or new instruction, and the advantages of active participation on the part of the student who must make a physical response in order to continue the instructional conversation. CAI has not had unqualified success, however, and research continues on the suitable use of this potentially powerful teaching aid.

One of the biggest problems associated with computer programmed instruction is the loading and storing of great amounts of instructional material on computer memory equipment. These methods are not efficient for compiling and reproducing expository material exceeding one or two sentences. For individual diagnostic teaching, a great deal of the effort is involved with step-by-step question, response, and evaluation. Educational material often needs, however, to be

presented with descriptive portions to assist the student in the verbalization and consequent internalization of larger concepts. Present methods for accomplishing this usually refer students to suggested optional textual materials, with the attendant problems of search and inconvenience. An auxiliary fiche reader can not only serve to fill this need, but can do so many times more efficiently than the usual reference texts because it can make immediately accessible on a single film card examples from many associated academic disciplines, various skill levels, and different points of view, each designed with internally supported and integrated access tools: i.e., editorial comments, cross-referencing, associated relevant material, etc. Conversely, CAI brings a desirable dimension to microfiche information units because of the capacity for processing anticipated but incorrect responses, thereby increasing the effectiveness of programmed instruction as an instrument for individualized diagnostic teaching.

CHAPTER III

CONSIDERATIONS IN A SPECIFIC INSTRUCTIONAL APPLICATION

This chapter considers the practical problems associated with the use of instructional microforms and develops a strategy for the successful introduction of one microform system (microfiche) into the training environment. The previous chapter has considered the links between educational theory and the design of filmed materials in order to achieve an active medium of instruction rather than simply a hard-copy substitute. The theme of "adding value" through the microform is also essential in the implementation, which includes a plan of delivery and of use.

The necessity for reading equipment, together with imagery that is not eye-legible, is clearly more demanding of the user than his familiar hardcopy. The successful introduction of microform, therefore, depends on the creation of a system of use so that the value added through the microform can be perceived by the trainee. There are three major elements in the system:

1. The plan for instructional materials.
2. The plan for delivery
3. The plan for use.

When these elements are understood, then the design and implementation of specific instructional applications can be developed; an outline is provided herein for such development.

A. The Plan For Instructional Materials

The commitment to develop instructional materials on fiche must be accompanied by a commitment to add value to the materials through utilization of the unique aspects of the microform presentation or the

endeavor will fail. This statement means that a change in medium for instructional materials must be justified on the basis of user benefits as well as administrative cost. Chapter II has considered some of the educational theory and certain strategies leading to added value and user benefits; this section will consider the development of instructional materials in an administrative context in order to set the stage for specific implementation of microform in a training environment.

The attractiveness of utilizing microform as a substitute for hardcopy training materials is extremely deceiving when the materials' production costs are considered alone. Utilization costs turn the picture around because of the capital required for reading equipment in addition to operating costs. The costs associated with the use of hardcopy materials in the resident training environment essentially cease with the distribution of the materials. When microform is utilized, the costs really begin after distribution of the film. This may be illustrated best through an example, drawing on the experience gained at Sheppard Air Force Base, Wichita Falls, Texas.

Assume a three-week training course, operating on two shifts, with a student load of 12 men per shift, 50 weeks a year. Further, assume that the Study Guides and Workbooks average 150 pages per week of instruction. Approximately 1200 students would receive training in a year's time and each student would require $9 worth of printed material.* (This example ignores the cost of preparing the "photoready" copy since it is also required in microfiche production.) Hardcopy, for a year's operations would cost $11,000. The cost of

* The cost of producing training materials in hardcopy is estimated at 2¢ a page, including storage and distribution, for runs of approximately 1000 copies.

providing 1200 sets of fiche, 5 fiche in a set (90 pages to a fiche with the new COSATI Standard), would cost approximately $300 in-house, and $600-$750 if produced by a commercial microfilm service organization.

The very favorable production picture changes dramatically when the costs of the readers are considered. Approximately 40 classroom readers would be required and 75 residential readers would be necessary for a student flow of 72 men. These readers would cost between $15,000 and $20,000; further, electrical power and maintenance costs would approach $1000 per year. The break-even point, using the microform instead of hardcopy, occurs after two years. This example has equated the production of the master fiche with the cost of producing offset plates, a very conservative approach since the plate cost would approach $100 while the filming cost would approach $50 if done commercially.

The picture drawn here has placed the cost of microform in a useful perspective. Since reader costs are significant, the major short-term cost benefit of the microfilm lies in those applications where (1) the amount of material is excessive, (2) an up-date or revision occurring more often than once a year is desirable, (3) distribution costs are important.

The development of microfiche, to include the concept of adding value, distorts this picture only at the point where the content of the Study Guides is prepared. The cost of additional fiche to implement an instruction sequence properly formatted to add value is small. For instance, if ten fiche were required instead of five, as in the above example, the added cost lies in the difference between in-house and commercial production of the dissemination copies. Proper formatting,

in the simplest sense, implies the design of the fiche to facilitate the instructional objectives, all the while consistent with the constraints of the display system. This implies that the creation of a master fiche will be more expensive than that presently associated with commercial practice. It implies that each master fiche be "composed" as the content is developed in order to identify classes of material and introduce examples, additional explanation, redundancy, and revision as required in the implementation of a formatting concept. The creation of the master is a labor-intensive step because the filming requires the production of intermediate negatives which, in turn, are used to produce a master fiche through a second filming step. Only through this intermediate step in the creation of the master can the fiche designer obtain control over the variety of input documentation that is appropriate to the film format. The intermediate negatives are arranged to provide the desired relationship between and among classes of information as dictated by the formatting concept employed. The variety of input might include color visuals, oversize schematics, blow-ups of drawings and photographic compensation for undersize type fonts and drawings. One extremely important advantage of the intermediate step in creation of the master fiche is the fact that updating and revision can be accomplished very easily: a new negative is simply stripped into the matrix of negatives assembled for the intermediate composition and then a new master fiche is produced.

The costs associated with the production of master fiche through the two-stage process are difficult to access and are beyond the scope of this Guide. But to establish a frame of reference, it might require four hours to produce a 90-frame master using the two-stage approach

and only 20 minutes to produce a master using the conventional "step-and-repeat" camera. This estimate, of course, does not deal with the substantial issues of verification and rework in case of filming errors.

The administrative considerations presented here introduce the considerations associated with delivery and use of microform in the training environment.

B. The Plan for Delivery

This section deals with the considerations involved in bringing the students, the hardware (viewers), and software together effectively in the training environment. The system of delivery affects everyone associated with the training process, but in different ways. The school administration particularly will make decisions at the outset that will define the direction and overall effectiveness of any conversion to a microform-based instructional medium. The primary element in the system of delivery is, of course, the viewing equipment itself, and the selection of this equipment will be discussed in detail below. The fact that equipment is involved has far-reaching consequences, particularly because of the requirement for a one-for-one relationship between students and viewers.

The presence of viewing equipment makes the classroom and the dormitory or residence an extension of the delivery system: these environments can contribute to the ease of equipment use in a direct way. Conversely, the microform system must be integrated with other media in these environments in order to achieve the full potential of the educational experience.

Equipment also implies logistical considerations. Storage, maintenance, power requirements, and abuse, are all factors related to delivery. Finally, substantial microform use implies new support personnel associated with implementing and sustaining the system.

1. Equipment Selection

Microform equipment to support instructional use of filmed materials is only now being seriously developed. In the near future, new models will be available from which to make equipment selection. How well a viewer performs is largely a matter of image quality and convenience of controls. Image quality can be evaluated by considering sharpness of the image, the quality of illumination, and the contrast. In making a selection, it is best to compare the images on the screens in their use environment because the image is the most important consideration. Factors which affect sharpness of input have to do with the original source material, the filming, or the projection equipment. There are several methods of measuring this, in lines per millimeter of resolution, and in terms of modulation transfer function which is best done in a laboratory with special equipment. Lines per millimeter is not an absolute measure and different people may get different numerical answers. The quality of illumination has to do with intensity and evenness. The use environment contributes significantly to this factor, as does the length of the focal path. The projection ratio affects illumination also, as does polarity of the film materials. Lack of contrast arises when light is reflected about inside the viewer and reaches the screen to wash out the image. Although it is best to inspect and compare readers on site, having established a class of readers from general specifications, there are basic requirements to be considered in selection; these include low cost; minimum time and effort to prepare for use, operation, and maintenance; optimum image presentation for maximum reading comfort; and minimum space occupied for a given projected information area. These may be amplified thus:

1. it must be easy to insert or remove the fiche or film without damaging it, and to rapidly locate onto the screen any of the frames

on any of a range of possible formats and, if necessary, to rotate any image to achieve right reading;

2. the image on the screen must be adequately legible (i.e. of adequate size, resolution, and contrast) under all likely ambient lighting conditions; the surface of the screen should preferably be normal to the sight line of the average seated user; eye strain with prolonged use should be minimal;

3. all controls must be readily accessible and visible to the user, and require minimum effort, mental and physical, to operate;

4. the reader must occupy minimum space, particularly minimum desk-top area, but must be adequately stable on a desk-top;

5. if portable, it must be small, easy to fold, or unfold, self-contained, robust, lightweight, and formed so as to be easy to transport or carry;

6. it must conform with relevant safety standards;

7. performance on a microfiche or microfilm viewer must not be compromised by attempts at versatility, in particular by accommodating other microforms;

8. form, color, surface textures and finishes should be compatible with foreseeable working environments;

9. servicing facilities must be available, and parts easy to replace.

In addition to the above, the following points should be particularly checked:

1. a hard, uniform focus, both in normal frame-to-frame operation and while scanning materials, must be maintained with a minimum of adjustments;

2. fan noise from equipment should be minimal or non-existent, especially in a classroom;

3. a "bright spot" in the center of the screen must be avoided when the viewer is destined for long periods of use;

4. the fiche loading and carriage mechanisms should be conveniently located and operate smoothly and with a minimum amount of force;

5. the lamp should combine adequate illumination characteristics with long life to reduce maintenance and classroom interruption due to equipment failure;

6. screens should be positioned at a height and an angle approximating that of the work surface insofar as this can be achieved; and

7. manipulation of machine parts should be accomplished with one hand in every possible instance.

2. The Use Environment

The classrooms to be used in the instructional sequence supported by a microform system should be examined to identify any changes necessitated by this use of machines. Primary consideration should be given the room size, power and lighting requirements, ventilation, and the general arrangement of the room itself for instructor-student interaction when viewers are in place for reference. Power considerations include the amount and distribution of the wiring and the location and compatability of the outlets with the viewers selected for classroom use. The particular arrangement of classrooms is dependent upon the type and size of the equipment used, room geometry, and the use of other visual aids such as chalkboard and slides. The classrooms should be arranged to optimize student-instructor eye-contact with consideration given to locating power outlets to achieve this goal. Each student should have his own work space in addition to his own reader. Careful consideration must be given to advanced

planning as regards scheduling for maximum utilization of both equipment and the classrooms if viewers are to be left in classrooms when not being used; when viewers are maintained continuously in classrooms they should be covered when not in use. If portable viewers are used to support the microform instructional system, the classrooms involved in relevant courses could be used in a normal fashion; in any event, any changes in the arrangement of classrooms to support microform systems should not interfere with classes using hardcopy materials.

For those classes supported by microform materials and which involve additional periods of study outside of the classroom, an adequate environment must be provided for machine use of the course materials contained in microform elsewhere. A work surface for study in dormitory or residence must be sufficient to hold the viewer, whether portable or of an institutional type, and also provide space for hardcopy materials such as workbooks and notebooks. If regulations require that the equipment be stowed when not in use, adequate provision must be made for storage. A comfortable, well-designed chair which moves about easily is important to the use of fixed reading equipment. A book can be moved about to achieve a different viewing position which retards the onset of eye and bodily fatigue; this same situation can be approximated, to some degree, by the moving of the student's chair forward and backward, and from side to side, while focusing upon a fixed screen image. Adequate illumination is needed for residential study as for classroom study, and power outlets must be available. Some degree of isolation for the student must be achieved insofar as noise and interruptions are concerned, and ventilation should be sufficient so that heat from lamps is readily dissipated, particularly in small rooms.

3. Handling and Storage

Arrangements must be made for the handling and storage of new equipment, the issuance and set-up of machines to be used as a micro-form-supported class convenes; and the receipt, maintenance, storage, and reissue of equipment as men depart and others are rotated into courses. Reading equipment should be stored in their original boxes to protect screens and minimize dust accumulation; the viewers should be examined, cleaned, and adjusted after each week's use, and prior to return to storage. A place for the accomplishment of this handling and issue, maintenance and storage, is required, as well as the personnel and procedures to support the operation. All equipment should be clean and operative at the time it is issued to students. If non-portable viewers are used in classrooms, they must be transported to the room, set into position, cleaned, and checked out prior to the first class meeting, which would require that such classrooms be vacant during off shifts. The viewer boxes would be retained in the assigned storage area. Viewers to be used in student residences should be cleaned, assembled, adjusted, and then returned to their boxes prior to delivery to students. If residential viewers are of the non-portable type, delivery schedules must be arranged and fulfilled. The procedure for issuing the viewers to students would be developed in a manner compatible with practices on the base or in the training environment where the micro-form system is to be employed.

4. Maintenance and Repair

A schedule must be established, and personnel made available to operate under it, for the periodic maintenance of viewing equipment, as well as for the necessary repair of equipment which malfunctions after being issued to a student or stationed in a classroom. All students

involved in microform-supported classes should be well instructed in proper use of equipment, the limits of their responsibility for it, and what to do in case of equipment failure. To properly maintain the necessary viewers, technicians adequately trained in the functioning of the equipment must be available. So that undue interruptions and delays are not encountered in classrooms, extra fiche, lamps, and a limited number of idle viewers should be maintained within classrooms. In accordance with administrative determinations, complete overhaul and replacement of viewing equipment should be scheduled.

5. Integration with Other Media

In this treatment, it is not expected that microfiche will stand alone as the total instructional medium. In the classroom, the instructor will bring his presentation to the students and the microform will support his course development. In turn, the microform will be supported by certain hardcopy materials, such as handouts and notebooks. Depending upon the course of instruction, other media may be employed in conjunction with the microform presentation, such as chalkboard demonstrations, slide presentations, and the use of three-dimensional models. In practice, the 35mm slide presentation particularly complements classroom use of film readers because the preferred ambient illumination levels are suitable for projection as well. In more sophisticated instructional environments, the microfiche may be an element in a sequence involving audio tapes in lieu of an instructor, or in combination with a programmed learning sequence involving computer control. The particular use of microforms, in combination with other media, and the level of its role in a mixed-media instructional situation, would be determined by materials and equipment availability, the educational strategy to be employed, and the degree of individualized

instruction completed for the student. The point to consider is that microforms are not expected to play the total instructional role, but to support and be supported by other educational components and strategies.

C. The Plan For Use

1. Indoctrination of Personnel

The effective utilization of microform materials and equipment for instructional purposes in educational and training environments requires a thorough indoctrination of the instructors who will employ them in the classroom and of the students who will use them as their primary resource medium. The wide variety of teaching approaches and techniques encountered in educational institutions suggests the need for a group indoctrination-demonstration of microform use in the classroom to allow instructors to share ideas of methodology and become aware of the advantages and possibilities of microform beyond their use as a book substitute. If a particular microform system has been selected for classroom use, the discussion should demonstrate its operating characteristics, indicate any disadvantages inherent in its use, and emphasize its flexibility as a teaching aid. This would allow individual instructors to decide how to incorporate the equipment and materials into their teaching method and to develop strategies to counteract or minimize the disadvantages of the system. The instructors could also consider ways to better employ the unique formatting or organizational capabilities of the fiche to present instructional materials in a way which improves the effectiveness of classroom instruction.

The students should also be given an orientation demonstration to help insure their successful utilization of the microform system. Basic to this orientation is a brief explanation of the microform concept and technology and an indication of the advantages of the system which

led to its use in the course in which they are enrolled. However, most emphasis should be placed on the equipment and materials to be used by the student. This includes a description of the software and adjunct reference materials to be used in connection with the equipment and a thorough explanation of the development and use of the format selected to present the material. The loading and operating characteristics of the viewing equipment should be demonstrated and all students should be given some "hands-on" experience with the viewers in order to become familiar with them. Finally, student responsibility for lost, stolen, or damaged equipment and procedures to follow in case of equipment failure should be firmly established.

2. Aids to Systematic Use

The implementation of microforms to present an instructional sequence should include the development of software support materials to be used in conjunction with the course. The support package should include detailed operating instructions, procedures to follow in case of equipment failure, methods for cleaning fiche, and an explanation of the fiche format used. However, the primary objective in the design of the package should be to provide ways to conveniently and effectively relate fiche materials to classroom lecture, notes, and adjunct reference materials. This requires, first of all, that the fiche themselves be organized and stored sequentially in a manner which provides easy access to individual fiche. Each fiche should contain an eye-legible heading which relates it by number (or position) and content to the instructional sequence. This heading should be visible to the user when the fiche is located in its storage container. Second, an index card or grid to be used with the viewer should be designed to coordinate with the fiche format so that, using this grid, the instructor can direct all students to the same fiche frame. Finally, the organization of

adjunct reference materials and paper for notetaking should be carefully planned so that these materials can be easily related to the fiche and to the lecture. One suggestion might be to provide students with a hardcopy outline of main topic areas and their location on the fiche, with space provided for student notes. This would give students a convenient way to relate their notes to the material contained on the fiche. Specialized hardcopy materials should be utilized in the support package where appropriate.

3. Problem Areas and Accommodations

Viewing equipment presently used in instructional environments has certain physical and operating limitations which require an accommodation by the user. For example, maintaining a hard, uniform focus on the viewer screen often requires frequent adjustment; fan noise can interfere with communication in the classroom, non-uniform illumination of the viewer screen results in a "hot spot"; and the inconvenient location of viewer controls make loading and maneuvering of fiche bothersome. These problems are emphasized or compounded by the size and geometry of the reader, which makes it necessary for students to adjust to the reader rather than incorporating the reader into their study methods. These viewer limitations emphasize the need for the development of microform reading equipment designed specifically for instructional applications. It is anticipated that as commercial development progresses, problems will be minimized, but the instructor should be aware that these difficulties will be encountered at the present time and certain allowances, such as breaks or the intermittent use of other media, could be helpful.

D. Outline For Design and Implementation

The further use of microfiche in the technical training environment requires detailed planning and coordination of effort on a broad

basis because of the systematic aspects of training school operations. The fundamental concern in any proposal to introduce microform as the medium of instruction is for the preservation of the essential feature of military training: that is, the effectiveness of an instructional procedure in combination with course content which has proven validity.

The plan of implementation provided below draws on the structure of the 3750th Technical Training School, Sheppard Air Force Base, Wichita Falls, Texas, in order to identify the essential units in the training environment that must interact successfully in order to initiate and sustain a microform based training program. The plan assumes that a program director, associated with the Department of Support Services, would have responsibility for the microform program. This approach is particularly recommended because this Department has responsibility for the preparation of all photo-ready materials through its graphic arts capability.

1. Administrative and Operational Units

There are three school elements affected by a decision to implement a microform program; in addition to the administrative personnel of the school, the training departments in the school, and the supporting service organizations are also involved. Some of the areas of involvement can be seen in the following listing.

a. The School Administration would consider:

Selection of the program director

Commitment of enabling funds

Creation of policies for course selection, review board responsibilities, operating procedures, and new squadron requirements

b. The School Department Directors would consider:

Facilities availability

Candidate courses for microform

Instructors' participation in the design of the microform format

Internal logistics (equipment-oriented)

Instructor training and student indoctrination

Evaluation for training objectives

c. The Supporting Departments would consider:

Production of microform materials

Maintenance of viewers

Provision for secondary training aids

Production of students' support materials (notebooks, etc.)

The actual instruction of trainees would occur under the direction of specific departments of the School. Within a department, The Curricula Unit, The Requirements Unit, The Instruction and Measurements Unit, and the Instructor Squadrons would be affected. The principal effects are associated with the initiation of instruction through microform; after start-up, the sustaining of the microform courses is the burden of the supporting departments, primarily.

2. Initiation of Materials Preparation

Once a course has been selected for presentation via the microfiche medium, the Study Guide for that course should be reviewed by representatives of the various units associated with the development of training materials. The School Project Officer would assume responsibility for the overall organization and development of the new materials, as well as the scheduling for art work, printing and film manufacture, and duplication. The Curricula Unit representative would be primarily

responsible for insuring that objectives of the Plan of Instruction are met and are emphasized to the trainee This would necessitate clear specification of goals and objectives within the non-optional instructional areas of the film card. Further, he might be expected to oversee the format details to which training documents must conform and to apply these requirements to the fiche Study Guide, e.g., positioning of titles, section headings, guide numbers, etc.

The responsibility for the actual writing or rearrangement of content would also fall within the activities of the Curricula Unit. Here, with the working cooperation of the Instructor Squadron, materials can be up-dated and rearranged to take advantage of the fiche capability for horizontal and vertical positioning of associated information, with non-essential information readily available to the trainee but not confused with the required POI presentation. The Instructor Squadron can be expected to contribute special insights gained from previous exposure to classes with the same objectives, identifying trouble spots so that the film medium can supply optional examples, illustrations and details, to identify the kinds of information students normally wish to highlight, and to indicate where students' interest in the general subject requires information not already included in the text.

The Instruction and Measurements Unit would take responsibility for coordinating materials with instruments of evaluation. Items for which there are test questions must be consistent with POI and must be treated within the main body of the Study Guide. As with any materials development for instructional purposes, the processes of development include input from administration, instructors, evaluators, and curricula coordinators. Increasing the options to the developers increases this need for coordination and cooperation.

3. Delivery Considerations

The actual use of the microform implies that the trainees, the instructors, the film materials, and the viewing equipment, have come together successfully. This assumes that:

a. The orientation procedure has been developed for the trainees by the instructors and Program Director.

b. The indoctrination plan has been prepared which "teaches" the instructors how to maximize use of the film in classes; and examines the role of other audio-visual media in further support of instructional objectives.

c. The Requirements Unit in the Department has developed schedules for routine maintenance of equipment, and the handling procedures for home viewer check-out, return, and storage.

d. The filmed training materials are available to the Department, together with all other student support materials that have been developed for the course.

It is extremely important that members of the Instructor Cadre participate in the selection of viewing equipment through actual trial. This is the crucial element in the delivery requirements and the instructors who will use the viewers routinely should make the final selection.

4. Use Requirements

The nature, duration, and content of the course of instruction will dictate the preparations necessary for facilitating the trainee's task. The microfiche must be packaged for student use and this "package" provides the opportunity to conveniently meet other student needs such as the documentation that he takes to his assignment in the field after the resident training is completed. The package might include an annotated outline of the plan of instruction for the course,

with provisions for the student to develop his specialized annotations for the identification and retrieval of important filmed sequences. Properly done, this package will serve as both an instructional and field document.

The possibility of including selected summary documentation in hardcopy form, bound into the package, should be examined. This material might include a basic flow diagram, an organizational chart, or any reference information that could be of a critical concern to the trainee and his performance. The philosophy guiding these efforts must be sensitive to the fact that the microimagery needs to be related to the eye-legible world in order to be satisfactory.

The development of these student aids is the responsibility of the program director, with input from the instructors, particularly those with field experience.

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13. ABSTRACT

This Guide presents information on the use of microforms in a training environment; to provide basic background on microforms as a distinct communications medium; and to illustrate the steps required in operationalizing the use of microforms in a training sequence.

A review of the material to be presented resulted in the preparation of three chapters for the instruction of individuals requiring an understanding of the subject: (1) general information on microforms to include definitions and explanations of terms, materials, and concepts; applications and acceptance; new techniques and processes; costs; and information sources; (2) the use of microforms in a direct instructional mode and the relationships of microform capabilities to training applications; and (3) the considerations to be taken into account in any specific instructional application, which include a plan for instructional materials, a plan for delivery, and a plan for use; as well as an outline for design and implementation of such an operation.

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